

Semiconductor devices —

Part 2: Integrated circuits —

Section 2.3 Recommendations for analogue integrated circuits

ICS 31.200

Committees responsible for this British Standard

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- British Broadcasting Corporation
- British Telecommunications plc
- Business Equipment Trade Association
- Electronic Components Industry Federation
- Electronic Engineering Association
- GAMBICA (BEAMA Ltd)
- Ministry of Defence
- National Supervising Inspectorate
- Society of British Aerospace Companies Limited
- Telecommunication Engineering and Manufacturing Association (TEMA)

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National foreword

This Section of BS 6493 has been prepared under the direction of the Electronic Components Standards Committee. It is identical with IEC Publication 748-3:1986 “*Semiconductor devices. Integrated circuits — Part 3: Analogue integrated circuits*” incorporating amendment 1:1991, amendment 2:1994 and corrigendum June 1996 to amendment 2:1994, published by the International Electrotechnical Commission (IEC).

This British Standard constitutes Section 2.3 of the British Standard for semiconductor devices (BS 6493). BS 6493 is identical with IEC Publications 747, 748 and 749 and will be issued in a series of separately published Sections corresponding to the individual Parts of the IEC publications.

Terminology and conventions. The text of the International Standard has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards; attention is drawn especially to the following:

Wherever page numbers are quoted, they are IEC page numbers.

Cross-references

International Standards	Corresponding British Standards
	BS 6493 <i>Semiconductor devices: discrete devices and integrated circuits</i>
IEC 747-1:1983	Section 1.1:1984 <i>General</i> (Identical)
IEC 748-1:1984	Section 2.1:1985 <i>General</i> (Identical)

The Technical Committee has reviewed the provisions of IEC 747-7, to which reference is made in Section 6 of Chapter III, and has decided that they are acceptable for use in conjunction with this standard.

Textual error. When adopting the text of the International Standard, the textual error given below was discovered. It has been marked in the text and has been reported to IEC in a proposal to amend the text of the International Standard.

In chapter III, section 7, in 2.1 the reference to “Figure 1” should be read as “Figure 46”.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 130, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Chapter I: General

1 Introductory note

As a rule, it will be necessary to use Publications 747-1 and 748-1 together with the present publication. In Publications 747-1 and 748-1, the user will find all basic information on:

- terminology;
- letter symbols;
- essential ratings and characteristics;
- measuring methods;
- acceptance and reliability.

The sequence of the different chapters in the present publication is in accordance with Publication 747-1, Chapter III, Sub-clause 2.1.

2 Purpose

The present publication gives standards on the following sub-categories of analogue integrated circuits:

- operational amplifiers (having two inputs and one output);
- audioamplifiers, videoamplifiers and multichannel amplifiers for telecommunications;
- R.F. and I.F. amplifiers;
- voltage and current regulators;
- analogue signal switching circuits.

Chapter II: Terminology and letter symbols

1 General terms

1.1 Voltage regulator

An integrated circuit that operates so that the load voltage remains relatively independent of load current or input voltage fluctuations.

NOTE The range of load current can usually be extended by the use of additional external components.

1.2 Current regulator

An integrated circuit that operates so that the load current remains relatively independent of load resistance or input voltage fluctuations.

NOTE The range of load resistance can usually be extended by the use of additional external components.

1.3 Crosstalk in data channels, general

1.3.1 Crosstalk (signal) in a data channel

An undesired signal appearing in a disturbed channel as a result of coupling from a disturbing channel.

1.3.2 Output (input) crosstalk (in a data channel)

The crosstalk signal present at the input (output) of the disturbed channel.

NOTE The letter symbol consists of the letter symbol for the relevant signal carrier, to which the letter x is added as last subscript. Example: V_{ix} , V_{ox}

1.3.3 Crosstalk attenuation (between terminals of data channels) α_x

The ratio of the signal value at a specified or output terminal of the disturbing channel, to the value of the crosstalk signal at a specified input or output terminal of the disturbed channel.

NOTE This ratio is normally expressed in decibels.

1.3.4 Crosstalk transfer ratio

The reciprocal value of crosstalk attenuation.

2 Terms related to ratings and characteristics

2.1 Linear amplifiers

2.1.1 Differential-mode voltage amplification (of a differential input linear amplifier) A_{VD} , A_{vd}

The ratio of the change in the magnitude of the output voltage to the change in the magnitude of the differential input voltage under specified conditions.

2.1.2 Common-mode voltage amplification (of a differential input linear amplifier) A_{VC} , A_{vc}

The ratio of the change in the magnitude of the output voltage to the change in the magnitude of the input voltage, the latter being applied equally and in phase to each input terminal, under specified conditions.

2.1.3 Common-mode rejection ratio (of a differential input linear amplifier) k_{CMR}

The ratio of the differential-mode voltage amplification to the common-mode voltage amplification, under the same specified conditions.

2.1.4 Input offset voltage V_{IO}

The d.c. voltage required to be applied between the input terminals of a differential amplifier for specified input and output circuits to cause the output voltage to attain a specified level, usually zero.

NOTE When the amplifier has balanced outputs, the specified output voltage refers to the difference in voltage between these outputs.

2.1.5 Input offset current I_{IO}

The d.c. current which has a value equal to the difference in the currents in the two input terminals which will cause the output voltage to attain a specified level, usually zero. The operating conditions, particularly output circuit, must be specified.

NOTE When the amplifier has balanced outputs, the specified output voltage refers to the difference in voltage between these outputs.

2.1.6 (Equivalent) input drift

The change in the input d.c. voltage or d.c. current (but with reversed sign) necessary to compensate for a change in output d.c. voltage or d.c. current, caused by a specified change of supply voltage, time, temperature or other environmental conditions.

2.1.7 Mean temperature coefficient of input offset voltage α_{VIO}

The quotient of the change of input offset voltage and the specified change of temperature causing it, all other conditions remaining constant.

2.1.8 Mean temperature coefficient of input offset current α_{IIO}

The quotient of the change of input offset current and the specified change of temperature causing it, all other conditions remaining constant.

2.1.9 Average (mean) bias current I_{IB}

The arithmetic average of the currents into specified differential input terminals when the device is in a quiescent state.

2.1.10 Input impedance

- a) *single-ended* z_{is}
 - the impedance from each input to the electrical reference point;
- b) *differential (-mode)* z_{id}
 - the impedance between two inputs;
- c) *common-mode* z_{ic}
 - the impedance between inputs in parallel and the electrical reference point.

2.1.11 Output impedance

- a) *single-ended* z_{os}
 - the impedance from each output to the electrical reference point,
- b) *differential (-mode)* z_{od}
 - the impedance between two outputs.

2.1.12 Maximum output voltage swing (of a linear amplifier) V_{OPP}

The maximum peak-to-peak output voltage which can be obtained without exceeding a specified distortion, when the quiescent d.c. output voltage is set to a specified reference level.

2.1.13 Common-mode input voltage range

The range of common-mode input voltage which, if exceeded, may cause the amplifier to cease to function within specification and/or cause irreversible change of characteristics.

2.1.14 Maximum rate of change of the output voltage S_{VOM}

The time rate of change of the output voltage (dv/dt) at the instant when that rate of change is largest in response to a specified step-function change of the input signal.

2.1.15 Average rate of change of the output voltage S_{VOAV}

For a step-function change of the input signal, the quotient of a specified large change of the output voltage and the time interval corresponding to that output voltage change.

2.1.16 Delay time t_d

The time interval between a step-function change of the input signal level and the instant at which the magnitude of the output signal passes through a specified value which is close to its initial value.

NOTE See Note 1 below.

2.1.17 Slope time (rise time, fall time) t_r , t_f

For a step-function change of the input signal level, the time interval between the end of the delay time and that instant at which the magnitude of the output signal first passes through a specified value close to its final value.

NOTE See Note 1 below.

2.1.18 Ripple time t_{rip}

For a step-function change of the input signal level, the time interval between the end of the slope time and that instant at which the magnitude of the output signal reaches, for the last time, a specified level range containing the final output signal level.

2.1.19 Ripple tolerance

The level range which is specified as containing the final value of the output signal.

NOTE The ripple tolerance is equal to 2ε (or $\pm \varepsilon$). (See ripple time and Figure 1, page 5.)

2.1.20 Total response time t_{tot}

The sum of delay time, slope time and ripple time.

NOTE 1 The level normally specified for the end of the delay time (the beginning of the slope time) is 10 %, that for the end of the slope time (the beginning of the ripple time) is 90 %.

The difference between the initial and final steady-state values of the output signal is defined as 100 %.

The level range specified for containing the final value of the output signal is $100 \% \pm \varepsilon$, where ε should be stated. See Figure 1.

2.1.21 Overshoot factor k_{OV}

Ratio of:

1) the largest deviation of the output signal value from its final steady-state value, after a step-function change of the input signal.

to:

2) the absolute value of the difference between the steady-state output signal values before and after the step-function change of the input signal.

2.1.22 Differential gain (error)

In a video amplifier, the difference between:

1) the ratio of the output amplitudes of a small high-frequency sinewave signal at two stated levels of a low-frequency signal on which it is superimposed, and:

2) unity.

NOTE 1 In this definition, “level” means a specified position on an amplitude scale applied to a signal waveform.

NOTE 2 The low-frequency and high-frequency signals should be specified.

NOTE 3 Differential gain may be expressed in per cent by multiplying the above difference by 100.

NOTE 4 Differential gain may be expressed in decibels by multiplying the common logarithm of the ratio described in Item 1) of this sub-clause by 20.

2.1.23 Differential phase (error)

In a video amplifier, the difference in output phase of a small high-frequency sinewave signal at two stated levels of a low-frequency signal on which it is superimposed.

NOTE 1 In this definition, “level” means a specified position on an amplitude scale applied to a signal waveform.

NOTE 2 The low-frequency and high-frequency signals should be specified.

2.1.24 Supply-voltage sensitivity k_{SVS}

The absolute value of the ratio of the change in input offset voltage to the corresponding change in value of one power-supply voltage, with all remaining power-supply voltages held constant.

2.1.25 Supply-voltage rejection ratio k_{SVR}

The absolute value of the ratio of the change in one power-supply voltage to the resulting change in input offset voltage, with all remaining power-supply voltages held constant.

2.1.26 Input voltage operating range

The range of the input voltage for which the amplifier functions within its specification.

2.1.27 Input current operating range

That range of the input current for which the amplifier functions within its specification.

2.1.28 Output voltage operating range

That range of the output voltage for which the amplifier functions within its specification.

2.1.29 Output current operating range

That range of the output current for which the amplifier functions within its specification.

2.1.30 Common-mode input voltage V_{IC}

The average of the two input voltages.

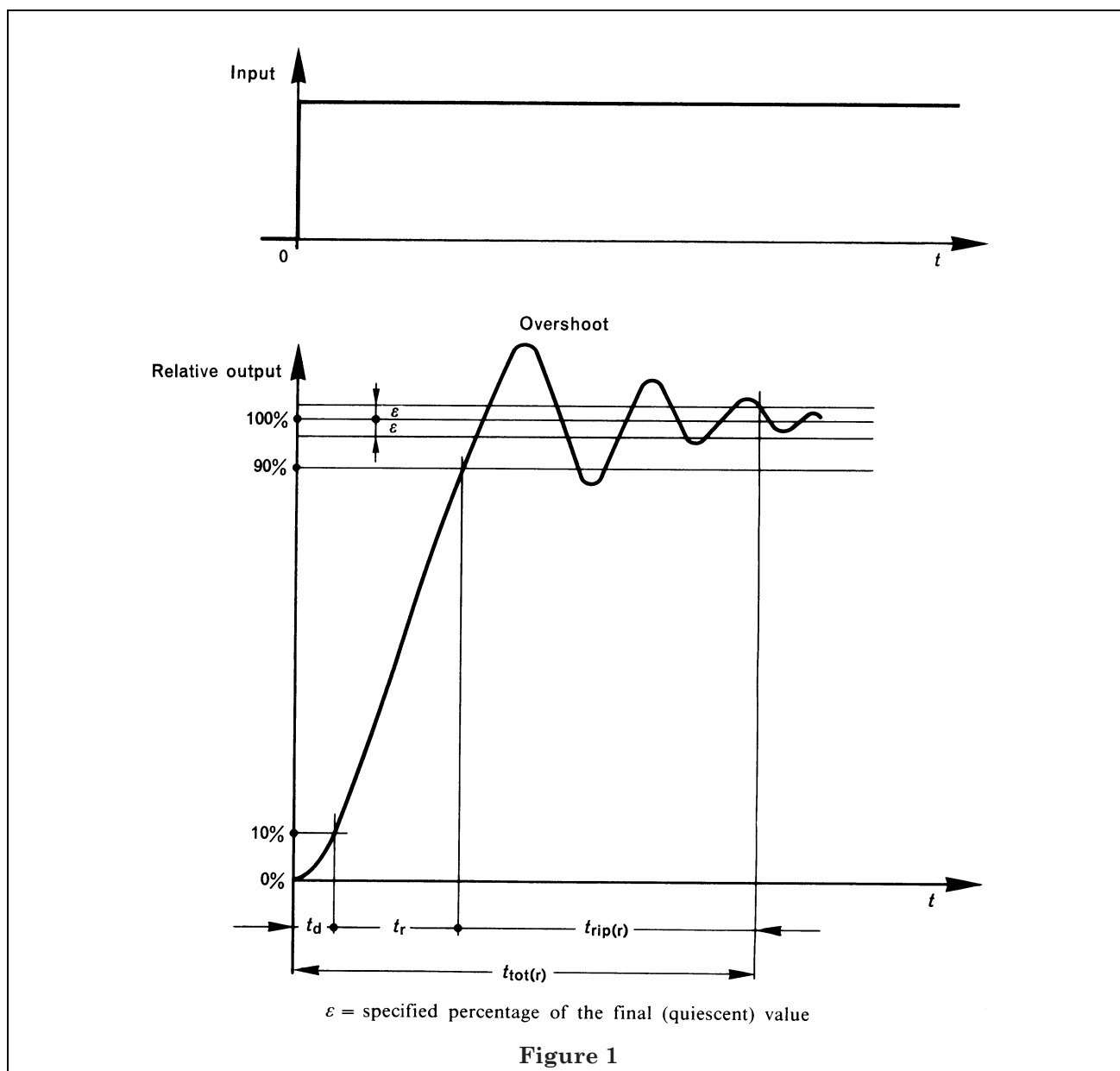


Figure 1

2.1.31 Differential-mode input voltage; differential input voltage V_{ID}

The input signal voltage between the differential input terminals.

2.1.32 Frequency of unity (open-loop) amplification f_1

The frequency at which the modulus of the voltage or current open-loop amplification is equal to unity.

NOTE There may be more than one frequency of unity (open-loop) amplification.

2.1.33 Extrapolated unity-gain frequency f_T

The product of the modulus of the voltage amplification $|A_v|$ and the frequency of measurement, this frequency being so chosen that $|A_v|$ is decreasing at a slope of approximately 6 dB per octave.

2.1.34 Open-loop cut-off frequency (of an operational amplifier) f_{co}

The frequency at which the modulus of the open-loop voltage amplification has decreased to $\frac{1}{\sqrt{2}}$ of its low-frequency value.

2.1.35 Crosstalk attenuation (for multiple operational amplifiers) α_x

The ratio of the output signal of one amplifier to the unwanted signal that it causes at the output of another amplifier when each amplifier is operating under specified conditions.

NOTE 1 This ratio is normally expressed in decibels. If the ratio is not expressed in decibels, it is necessary to state whether the output signals are voltages, currents or powers.

NOTE 2 "Crosstalk" is the inverse of "crosstalk attenuation".

2.1.36 Crosstalk in multiple operational amplifiers**2.1.36.1 (Output) crosstalk attenuation** α_{xo} , α_x

The ratio of the signal voltage $V_o(A)$ at the output of the disturbing amplifier, to the crosstalk signal voltage $V_o(B)$ at the output of the disturbed amplifier.

NOTE 1 This ratio is normally expressed in decibels:

$$\alpha_{xo} [\text{dB}] = 20 \lg [V_o(A)/V_o(B)].$$

NOTE 2 The longer term and letter symbol should only be used when distinction must be made between the output crosstalk attenuation and the equivalent input crosstalk attenuation (see 2.1.36.2).

2.1.36.2 Equivalent input crosstalk attenuation α_{xi}

The quotient of the output crosstalk attenuation by the closed-loop voltage amplification $A_v(B)$ of the disturbed amplifier.

NOTE The value of α_{xi} is normally expressed in decibels:

$$\alpha_{xi} [\text{dB}] = 20 \lg \left(\frac{V_o(A)}{V_o(B) \cdot A_v(B)} \right)$$

CAUTION: The input of an amplifier with external feedback is not necessarily at the terminals of the device.

2.2 Voltage and current regulators**2.2.1 Voltages****2.2.1.1 Output transient overshoot voltage** V_{om}

The difference between the peak value of the transient output voltage and the final steady-state output voltage following a specified step change of any condition applied.

NOTE Examples of such conditions that may be specified:

- a) input voltage;
- b) output current;
- c) control input;
- d) reference voltage.

2.2.1.2 Feedback sense voltage v_{FB}

A voltage that is a function of the output voltage and is used, with or without external components, for feedback control of the regulator.

2.2.1.3 Current-limiting voltage V_{CL}

The value of the voltage applied between specified terminals at which limiting of the output current commences.

NOTE Usually, this voltage is derived from the output load current.

2.2.1.4 Reference voltage V_{REF}

The voltage with which the feedback sense voltage is compared in order to control the regulator.

NOTE This voltage may be derived from an internal or external network.

2.2.1.5 Output noise voltage V_{no} , V_{nopp}

The noise voltage at the output of the regulator arising from the device only.

NOTE This voltage may be expressed as either a root-mean-square or a peak-to-peak value.

2.2.1.6 Input regulation range

The range of input voltages for which input regulation or input stabilization coefficients are specified.

2.2.2 Currents**2.2.2.1 Stand-by current**

The supply current drawn by the regulator with no output load.

2.2.2.2 Short-circuit current

The output current with the output shorted to ground or to another specified reference voltage.

2.2.3 Regulation and stabilization characteristics of voltage regulators

NOTE In terms of large signal characteristics, the qualifier “large signal” may be omitted, if no ambiguity is likely to occur.

2.2.3.1 (Large signal) input regulation factor R_I

The relative change in output voltage resulting from a specified change in input voltage, other conditions being held constant:

$$R_I = \frac{\Delta V_O}{V_O} \quad (\text{for } \Delta V_I \text{ specified})$$

2.2.3.2 Line regulation (as an alternative term in 2.2.3.1)

A term used in specifications to denote a maximum absolute value for the quotient $\Delta V_O/V_O$ that will nowhere be exceeded within a specified operating range of input voltage, output load and other conditions being held constant.

2.2.3.3 (Large signal) input stabilization factor S_I

The ratio of the relative change in output voltage to a specified relative change in input voltage, other conditions being held constant:

$$S_I = \frac{\Delta V_O/V_O}{\Delta V_I/V_I}$$

2.2.3.4 (Large signal) load regulation factor R_O

The relative change in output voltage resulting from a specified change in output current, other conditions being held constant:

$$R_O = \frac{\Delta V_O}{V_O} \quad (\text{for } \Delta I_O \text{ specified})$$

2.2.3.5 Load regulation (alternative term in 2.2.3.4)

A term used in specifications to denote a maximum absolute value for the quotient $\Delta V_O/V_O$ that will nowhere be exceeded within a specified operating range, I_O , V_I and other conditions being held constant.

NOTE In specifications, usually a typical curve for $\Delta V_O/V_O = f(I_O)$ is given for this operating range of I_O . See Figure 54.

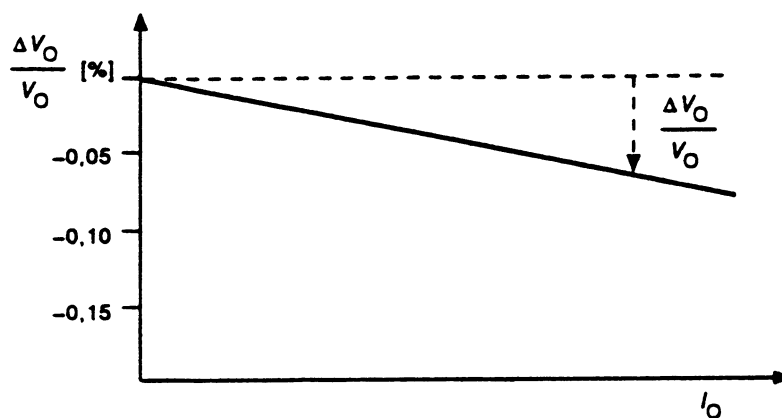


Figure 54 — Load regulation $\Delta V_O/V_O$ as a function of output current I_O

2.2.3.6 (Large signal) load regulation coefficient $R_{O, \text{rel}}$

The quotient of:

- the relative change in output voltage resulting from a specified change in output current produced by a change in output load; by
- that change in output current;

other conditions being held constant:

$$R_{O, \text{rel}} = \frac{\Delta V_O / V_O}{\Delta I_O}$$

NOTE $R_{O, \text{rel}}$ is an inherent characteristic of a voltage regulator, because $\Delta V_O / V_O$ decreases nearly linearly with ΔI_O . See the constant slope of the curve $\Delta V_O / V_O = f(I_O)$, shown in Figure 54.

2.2.3.7 Small signal load regulation coefficient $R_{o, \text{rel}}$

The quotient of:

- the relative small signal output voltage resulting from a small change of the output current; by
- that change of output current;

other conditions being held constant:

$$R_{o, \text{rel}} = \frac{v_o / V_O}{i_o}$$

NOTE For the same reasons as for $R_{O, \text{rel}}$, $R_{o, \text{rel}}$ is an inherent characteristic of a voltage regulator.

2.2.3.8 Small signal load stabilization factor S_o

The quotient of:

- the relative change of output voltage resulting from a small signal change of output current; by
- the relative change of output current;

other conditions being held constant:

$$S_o = \frac{v_o / V_O}{i_o / I_O}$$

2.2.4 Sundry quantities**2.2.4.1 Temperature coefficient of regulated output voltage (of a voltage regulator)**

The ratio of the relative change in output voltage to a specified change in temperature, other conditions being held constant.

$$\frac{\Delta V_o / V_o}{\Delta T}$$

2.2.4.2 Temperature coefficient of regulated output current (of a current regulator)

The ratio of the relative change in output current to a specified change in temperature, other conditions being held constant.

$$\frac{\Delta I_o / I_o}{\Delta T}$$

2.2.4.3 Input transient recovery time

The time interval between a specified step-function change of the input voltage and the instant when the magnitude of the output voltage (or current) enters for the last time a specified range containing the final output level.

2.2.4.4 Load transient recovery time

The time interval between a specified step-function change of the load and the instant when the magnitude of the output voltage (or current) enters for the last time a specified range containing the final output level.

2.2.4.5 Ripple rejection ratio

The ratio of the peak-to-peak input ripple voltage to the peak-to-peak output ripple voltage.

2.2.4.6 Output voltage drift $\Delta V_{o(t)}$

The change in output voltage for a specified long period of time, other conditions being held constant.

2.2.4.7 Output current drift $\Delta I_{o(t)}$

The change in output current for a specified long period of time, other conditions being held constant.

2.2.5 Regulation and stabilization characteristics of current regulators

2.2.5.1 (Large signal) input stabilization factor S_I

The ratio of the relative change in output current to a specified relative change in input voltage, other conditions being held constant:

$$S_I = \frac{\Delta I_o / I_o}{\Delta V_I / V_I}$$

2.2.5.2 (Large signal) load regulation factor R_O

The relative change in output current resulting from a specified change in output voltage, other conditions being held constant:

$$R_O = \frac{\Delta I_O}{I_O} \quad (\text{for } \Delta V_O \text{ specified})$$

2.2.5.3 Small signal load regulation factor $R_{o, \text{rel}}$

The quotient of:

- the relative small signal output current resulting from a small change in output voltage; by
- that change in output voltage;

other conditions being held constant:

$$R_{o, \text{rel}} = \frac{i_o / I_O}{v_o}$$

NOTE For the same reasons as for $R_{o, \text{rel}}$, $R_{o, \text{rel}}$ is an inherent characteristic of a current regulator.

2.2.5.4 Small signal load stabilization factor S_O

The quotient of:

- the relative change in output current resulting from a small signal change in output voltage; by
- the relative change in output voltage;

other conditions being held constant:

$$S_O = \frac{i_o / I_O}{v_o / V_O}$$

2.3 Analogue signal switching circuits

2.3.1 (Switch) input off-state leakage current of an analogue signal switching circuit $I_{I(\text{lk, off})}$

The current in the signal input terminal that is produced by a voltage applied between the signal input terminal and the common reference terminal of the circuit when the switch is in the off-state.

NOTE If there is no ambiguity, the letter symbol $I_{I(\text{off})}$ may be used.

2.3.2 (Switch) output off-state leakage current of an analogue signal switching circuit $I_{O(\text{lk, off})}$

The current in the signal output terminal that is produced by a voltage applied between the signal output terminal and the common reference terminal of the circuit when the switch is in the off-state.

NOTE If there is no ambiguity, the letter symbol $I_{O(\text{off})}$ may be used.

2.3.3 (Switch) on-state leakage current of an analogue signal switching circuit $I_{(\text{lk}, \text{on})}$

The current in the signal input (or output) terminal that is produced by a voltage applied between the signal input (or output) terminal and the common reference terminal of the circuit when the switch is in the on-state.

NOTE 1 Due to the low on-state resistance of the switch, the measured values at the input or the output terminal will be practically the same. Therefore, only one value is specified which may be measured either at the input or the output terminal.

NOTE 2 If there is no ambiguity, the letter symbol $I_{I/O(\text{on})}$ may be used.

2.3.4 On-state resistance r_{ON}

The d.c. resistance between the signal input and output terminals when the switch is in the on-state.

2.3.5 On-state control feedthrough voltage $\Delta V_{\text{OCF}(\text{on})}$

The change in the value of the output voltage of an analogue switch that is in the on-state due to specified change in the control input voltage applied to the same switch, all other conditions remaining constant.

2.3.6 Off-state control feedthrough voltage $\Delta V_{\text{OCF}(\text{off})}$

The change in the value of the output voltage of an analogue switch that is in the off-state due to specified change in the control input voltage applied to the same switch, all other conditions remaining constant.

2.3.7 On-state crosstalk attenuation (of a multiple analogue signal switching circuit) $\alpha_{x(\text{on})}$

The ratio of the output voltage of an analogue switch that is in the on-state to the unwanted voltage it causes at the output of another analogue switch that is in the on-state.

2.3.8 Off-state crosstalk attenuation (of a multiple analogue signal switching circuit) $\alpha_{x(\text{off})}$

The ratio of the output voltage of an analogue switch that is in the on-state to the unwanted voltage it causes at the output of another analogue switch that is in the off-state.

2.3.9 Crosstalk attenuation in multiple analogue signal switching circuits

NOTE Crosstalk attenuation is normally expressed in decibels, using the formula:

$$\alpha_x [\text{dB}] = 20 \lg (V_1/V_2)$$

2.3.9.1 (On-state) crosstalk attenuation $\alpha_{x(\text{on})}$, α_x

The ratio of the output voltage of a disturbing analogue switch that is in the on-state, to the crosstalk voltage it causes at the output of a disturbed analogue switch that is in the on-state.

NOTE The longer term and letter symbol should only be used when distinction must be made between the on-state crosstalk attenuation and the off-state crosstalk attenuation (see 3.2).

2.3.9.2 (Off-state) crosstalk attenuation $\alpha_{x(\text{off})}$

The ratio of the output voltage of a disturbing analogue switch that is in the on-state, to the crosstalk voltage it causes at the output of a disturbed analogue switch that is in the off-state.

2.3.9.3 Input crosstalk attenuation α_{xi}

The ratio of the input voltage of a disturbing analogue switch that is in the off-state, to the crosstalk voltage it causes at the output of a disturbed analogue switch that is in the on-state.

2.4 Integrated circuit microwave amplifiers (under consideration)

3 Letter symbols

3.1 Linear amplifiers

Name and designation	Letter symbol	Remarks
3.1.1 Voltages and currents		
Input offset voltage	V_{IO}	
Maximum output voltage swing	V_{OPP}	
Input offset current	I_{IO}	
Bias current of an input terminal	$I_{IB}; I_{IB1}; I_{IB2}$	
Average (mean) bias current	I_{IB}	
Common-mode input d.c. voltage	V_{IC}	
Differential-mode input d.c. voltage	V_{ID}	
3.1.2 Electrical parameters		
Input impedance: — single-ended — differential (-mode) — common-mode	Z_{is} Z_{id} Z_{ic}	
Output impedance: — single-ended — differential (-mode)	Z_{os} Z_{od}	
3.1.3 Switching times (see Figure 2, page 14)		
Delay time	$t_d; t_{dr}; t_{df}$	
Slope time: — rise time — fall time	t_r t_f	
Ripple time	$t_{rip}; t_{rip(r)}; t_{rip(f)}$	
Total response time	$t_{tot}; t_{tot(r)}; t_{tot(f)}$	
3.1.4 Sundry quantities		
Differential-mode voltage amplification	$A_{VD}; A_{vd}$	
Common-mode voltage amplification	$A_{VC}; A_{vc}$	
Maximum rate of change of the output voltage	S_{VOM}	
Average rate of change of the output voltage	S_{VOAV}	
Mean temperature coefficient of input offset voltage	α_{VIO}	
Mean temperature coefficient of input offset current	α_{IIO}	
Overshoot factor	k_{OV}	
Frequency of unity (open-loop) amplification	f_I	
Supply-voltage sensitivity	k_{SVS}	

Name and designation	Letter symbol	Remarks
Supply-voltage rejection ratio	k_{SVR}	The abbreviations SVRR, SVR and PSRR are in common use for this quantity
Common-mode rejection ratio	k_{CMR}	The abbreviations CMRR and CMR are in common use for this quantity
Extrapolated unity-gain frequency	f_{T}	
Open-loop cut-off frequency (of an operational amplifier)	f_{CO}	
Attenuation	a	
Crosstalk attenuation (for multiple amplifiers)	a_{X}	

3.2 Voltage and current regulators

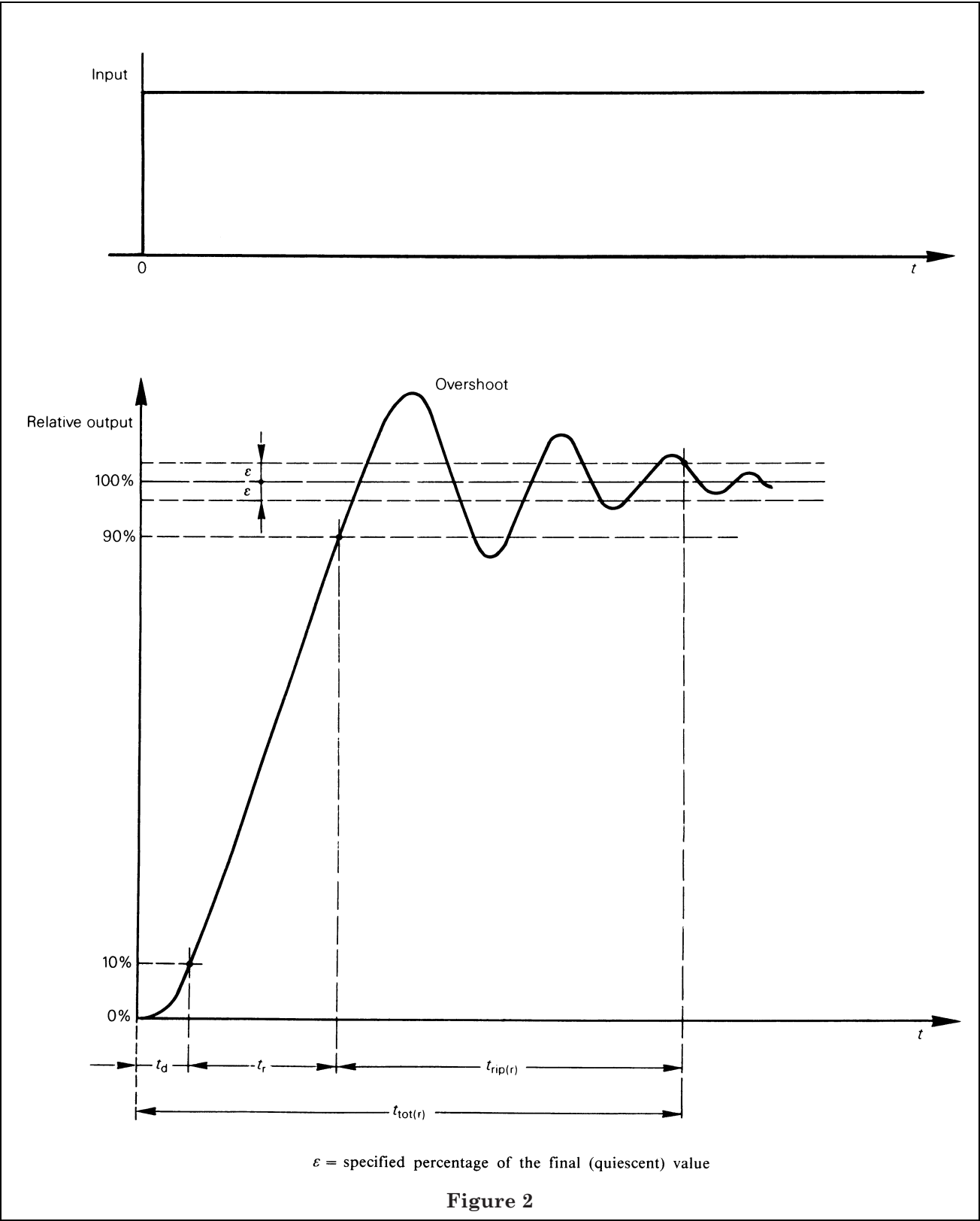
Name and designation	Letter symbol	Remarks
3.2.1 Voltages		
Output transient overshoot voltage a) due to an input voltage step b) due to an output current step	V_{om} $V_{\text{om(VI)}}$ $V_{\text{om(IO)}}$	
Feedback sense voltage	V_{FB}	
Current-limiting voltage	V_{CL}	
Reference voltage	V_{REF}	
Output noise voltage: root-mean-square peak-to-peak	V_{no} V_{nopp}	
3.2.2 Currents Under consideration.		
3.2.3 Regulation coefficients, stabilization coefficients.		
No special letter symbols are given. If necessary, the formulae given together with the definitions of the terms (see Sub-clause 2.2) may be used.		
3.2.4 Sundry quantities		
Output voltage drift	$\Delta V_{\text{o(I)}}$	
Output current drift	$\Delta I_{\text{o(I)}}$	

3.3 Analogue signal switching circuits

Name and designation	Letter symbol	Remarks
3.3.1 Currents		
(Switch) input off-state leakage current	$I_{I(lkg, off)}$	If no ambiguity, $I_{I(off)}$ may be used
(Switch) output off-state leakage current	$I_{O(lkg, off)}$	If no ambiguity, $I_{O(off)}$ may be used
(Switch) on-state leakage current	$I_{(lkg, on)}$	If no ambiguity, $I_{I/O(on)}$ may be used
3.3.2 Voltages		
On-state control feedthrough voltage	$\Delta V_{OCF(on)}$	
Off-state control feedthrough voltage	$\Delta V_{OCF(off)}$	
3.3.3 Electrical parameters		
On-state resistance	γ_{ON}	
3.3.4 Sundry quantities		
On-state crosstalk attenuation (for multiple switching circuits)	$a_{x(on)}$	
Off-state crosstalk attenuation (for multiple switching circuits)	$a_{x(off)}$	
Input crosstalk attenuation (for multiple switching circuits)	$a_{x(in)}$	

3.4 Integrated circuit microwave amplifiers

Name and designation	Letter symbol	Remarks
3.4.1 Gains		
Linear gain	G_{lin}	
Linear gain flatness	ΔG_{lin}	
Power gain	G_p	
Power gain flatness	ΔG_p	
3.4.2 Powers		
Output power	P_o	
Output power at 1 dB gain compression	$P_{o(1\text{ dB})}$	
Limited output power	$P_{o(ltd)}$	
Limited output power flatness	$\Delta P_{o(ltd)}$	
Minimum input power for limited output power	$P_{i\ min}$	
Maximum input power for limited output power	$P_{i\ max}$	
Ratio of output powers for intermodulation products	P_1/P_n	
3.4.3 Sundry quantities		
Magnitude of the input reflection coefficient (return loss)	s_{11}	
Magnitude of the reverse transmission coefficient (isolation)	s_{12}	
Conversion coefficient of amplitude modulation to phase modulation	$\alpha_{(AM-PM)}$	
Group delay time	$t_{d(grp)}$	
Time constant for automatic gain control	τ_{AGC}	



Chapter III: Essential ratings and characteristics

Section 1. Standard format for the presentation of published data

1 Function

A general description of the function performed by the analogue circuit.

2 Description of circuit

2.1 Technology

The technology used in the manufacture should be stated, e.g. semiconductor monolithic integrated circuit, thin film integrated circuit, hybrid integrated circuit, micro-assembly etc.

2.2 Details of outline and encapsulation

2.2.1 IEC and/or national reference number of the outline drawing.

2.2.2 Method of encapsulation.

2.2.3 Marking: the drawing of the case with the marking should be reproduced.

2.3 Block-diagram and terminal connections

The block-diagram and the identification of the connections should be shown on the same drawing. If the encapsulation has metallic parts, any connection to them from external terminals should be indicated. The connections with any associated external electrical elements should be stated (see also Clause 5).

As additional information, the complete electrical diagram can be reproduced, including significant parasitic elements, but not necessarily with indications of the values of the circuit components.

3 Ratings (limiting values)

The ratings given must cover the operation of the integrated circuit over the specified range of operating temperatures.

Where such ratings are temperature dependent, this dependence should be indicated.

3.1 Electrical limiting values

The absolute limiting values (including polarity) for voltages and/or currents and/or impedances, together with any other limiting conditions, should be stated for the various terminals, with respect to a reference terminal.

3.2 Temperatures

Limiting values of operating temperature and storage temperature.

3.3 Power dissipation (where appropriate)

Maximum value over the operating temperature range.

4 Recommended operating conditions (within the specified operating temperature range)

For all the sub-clauses of Clause 4 below, the variation with temperature should be stated, where appropriate.

4.1 Power supplies

Polarities, values and tolerances for voltages or currents and, where appropriate, impedances.

4.2 Input terminals

Polarities and characteristics of the input signals or of the generator.

4.3 Output terminals

Characteristics of loads.

4.4 External elements

Values and tolerances for the external elements that must be associated with the circuit.

5 Electrical characteristics

Electrical characteristics should be stated as follows:

- a) If external elements are essential for the operation of the circuit, the electrical characteristics should include the effect of such external elements.
- b) If external elements are optional only, the electrical characteristics should be given for the integrated circuit alone. The effect of adding specified external elements on the characteristics should then be indicated in application data.

5.1 Characteristics at 25 °C (ambient or reference-point temperature)

5.1.1 Power (or supply current) consumption.

5.1.2 Input characteristics.

5.1.3 Output characteristics.

5.1.4 Forward transfer characteristics.

5.1.5 Reverse transfer characteristics (where appropriate).

5.1.6 Interaction between the different terminals of the device (where appropriate).

5.1.7 Noise (where appropriate).

5.2 Effects of variations of temperature and supply voltages on the essential characteristics (where appropriate)

6 Mechanical characteristics and other data

Under consideration. Clause 7 of Publication 747-1, Chapter VI, applies.

7 Application data

Information concerning the variations of the characteristics given in Sub-clause 5.1 with supply voltage, temperature, source and load impedances, may be given.

Any other pertinent information concerning particular applications may be given.

Section 2. Operational amplifiers (having two inputs and one output)

1 Function

Amplifier intended to effect mathematical operations when used in a closed loop.

The characteristics of an operational amplifier approximate those of an ideal amplifier which may be either a voltage or a current type amplifier.

The ideal voltage amplifier is characterized by:

- an infinite voltage gain;
- an infinite input impedance;
- a zero output impedance;
- a bandwidth starting from zero frequency.

The ideal current amplifier is characterized by:

- an infinite current gain,
- a zero input impedance,
- an infinite output impedance,
- a bandwidth starting from zero frequency.

NOTE The characteristics of an operational amplifier are such that it can be used for many applications other than those given above.

2 Description of circuit

2.1 Technology

The technology used in the manufacture should be stated, e.g.: semiconductor monolithic integrated circuit, thin film integrated circuit, hybrid integrated circuit, micro-assembly, etc.

2.2 Details of outline and encapsulation

2.2.1 IEC and/or national reference number of the outline drawing.

2.2.2 Method of encapsulation.

2.2.3 Marking: the drawing of the case with the marking should be reproduced.

2.3 Block-diagram and terminal connections

The block-diagram and the identification of the connections should be shown on the same drawing. If the encapsulation has metallic parts, any connection to them from external terminals should be indicated. The connections with any associated external electrical elements should be stated (see also Clause 5).

As additional information, the complete electrical diagram can be reproduced, including significant parasitic elements, but not necessarily with indications of the values of the circuit components.

3 Ratings (limiting values)

The ratings given must cover the operation of the integrated circuit over the specified range of operating temperatures.

Where such ratings are temperature-dependent, this dependence should be indicated.

3.1 Electrical limiting values

3.1.1 *Power supply voltage(s)*

- a) Maximum value(s) and polarity(ies).
- b) Maximum permissible ripple on the supply voltage(s).
- c) Maximum values of transients or spurious signals from the supplies for a specified time duration.
- d) Maximum value of the voltage between a common supply terminal and case or reference terminal, where appropriate.

NOTE The sequence of the application of supply voltages should be given, where appropriate.

3.1.2 *Power supply current(s)*

- a) Maximum values, where appropriate.
- b) Maximum values for a specified duration (external fault conditions), where appropriate.

3.1.3 *Input terminal voltages*

Maximum values, with respect to a common reference terminal, including bias voltages.

Maximum value between input terminals.

3.1.4 *Output terminal voltages*

Maximum values, with respect to a common reference terminal, including bias voltages.

3.1.5 *Input terminal currents*

Maximum values, including bias currents.

3.1.6 *Output terminal currents*

Maximum values, including bias currents.

3.1.7 *Impedances (where appropriate)*

Maximum values for the impedances of the supplies to which the circuit is connected.

3.1.8 *Short-circuit conditions (where appropriate)*

Maximum duration of a short-circuit between terminals or between terminals and ground.

3.2 Temperatures

3.2.1 *Operating temperatures*

Minimum and maximum values of ambient or reference-point operating temperature.

3.2.2 *Storage temperatures*

Minimum and maximum values.

3.3 Power dissipation (where appropriate)

Maximum value over the operating temperature range.

4 Recommended operating conditions (within the specified operating temperature range)

For all the sub-clauses of Clause 4 below, the variation with temperature should be stated, where appropriate.

4.1 Power supplies

4.1.1 Polarities, values and tolerances for voltages or currents and, where appropriate, impedances.

4.1.2 Nominal value(s) of the supply current(s).

4.1.3 Maximum value(s) of the impedance(s) of the supplies, where appropriate.

4.2 Input terminals

4.2.1 Value(s) of the voltage(s) and/or current(s) of the input signal or of the signal generator.

4.2.2 Value(s) of the bias on the input terminals, where appropriate.

4.3 Output terminals

4.3.1 Nominal value(s) of the voltage(s) and/or current(s) of the output signal and of the load impedance.

4.3.2 Value(s) of the bias on the output terminals, where appropriate.

4.4 External elements

Values and tolerances for the external elements that must be associated with the circuit.

5 Electrical characteristics

Electrical characteristics should be stated as follows:

- a) If external elements are essential for the operation of the circuit, the electrical characteristics should include the effect of such external elements.
- b) If external elements are optional only, the electrical characteristics should be given for the integrated circuit alone. The effect of adding specified external elements on the characteristics should then be indicated in application data.

5.1 Characteristics at 25 °C (ambient or reference-point temperature)

5.1.1 *Power (or supply current) consumption* (P_{tot})

Typical value under specified conditions.

5.1.2 *Input characteristics*

5.1.2.1 *Input impedance or admittance*

Minimum and maximum values for specified values of:

- load impedance;
- measuring frequency;
- input signal amplitude.

5.1.2.2 *Magnitude of input offset voltage and/or current* (V_{IO} , I_{IO})

Maximum values for specified values of source resistances, if they affect the values of these characteristics.

5.1.2.3 *Input bias current* (I_{IB})

Maximum value for zero or specified voltage in common mode.

5.1.2.4 (Equivalent) input drift

Maximum value under specified conditions.

5.1.2.5 Common-mode rejection ratio (k_{CMR})

Minimum or maximum value for specified values of:

- amplitude of input signal in common mode;
- output voltage with zero input signal in common mode;
- supply voltage(s);
- frequency;
- adjustment of the gain control (if it exists);
- load and source impedances.

5.1.2.6 Common-mode input voltage range

Minimum and maximum values for specified values of:

- supply voltage(s);
- load and source impedance(s);
- common-mode rejection ratio;
- additional components to be connected externally.

5.1.3 Output characteristics**5.1.3.1 Output impedance or admittance**

Minimum and/or maximum values for specified values of:

- supply voltage(s);
- source impedance;
- frequency;
- output signal amplitude.

5.1.3.2 Maximum rate of change of the output voltage (for large-signal operation) (S_{VOM})

Typical and, where appropriate, minimum value(s) under specified conditions.

NOTE The rise and/or fall time of the input pulse should be negligible compared to the slope time of the operational amplifier.

5.1.3.3 Output voltage swing (V_{OPP})

Typical and minimum values for specified supply voltage and load resistance and, where appropriate, for a specified value of total distortion.

5.1.3.4 Short-circuit output current

Minimum and, where appropriate, maximum values for specified values of:

- supply voltage(s);
- differential and common-mode input voltages;
- duration of the short-circuit, where appropriate.

5.1.4 Forward transfer characteristics**5.1.4.1 Open-loop gain**

Minimum and maximum values for specified values of:

- supply voltage(s);
- frequency;
- adjustment of the gain control (if it exists);
- load and source impedance(s);
- amplitude of the output signal at which the gain is measured.

5.1.4.2 Operation with sinusoidal and/or pulse signals

Maximum and/or minimum values for one or more of the following characteristics:

- frequency for which the open-loop gain has decreased by 3 dB from its low frequency value;
- frequency for unity gain;
- pulse response time.

5.1.4.3 Response times

The following times shall be specified:

- delay time: t_d
- slope time: t_r (or t_f)
- ripple time: t_{rip}
- total response time: t_{tot}

Only three of these four parameters shall be stated (see Figure 3 below).

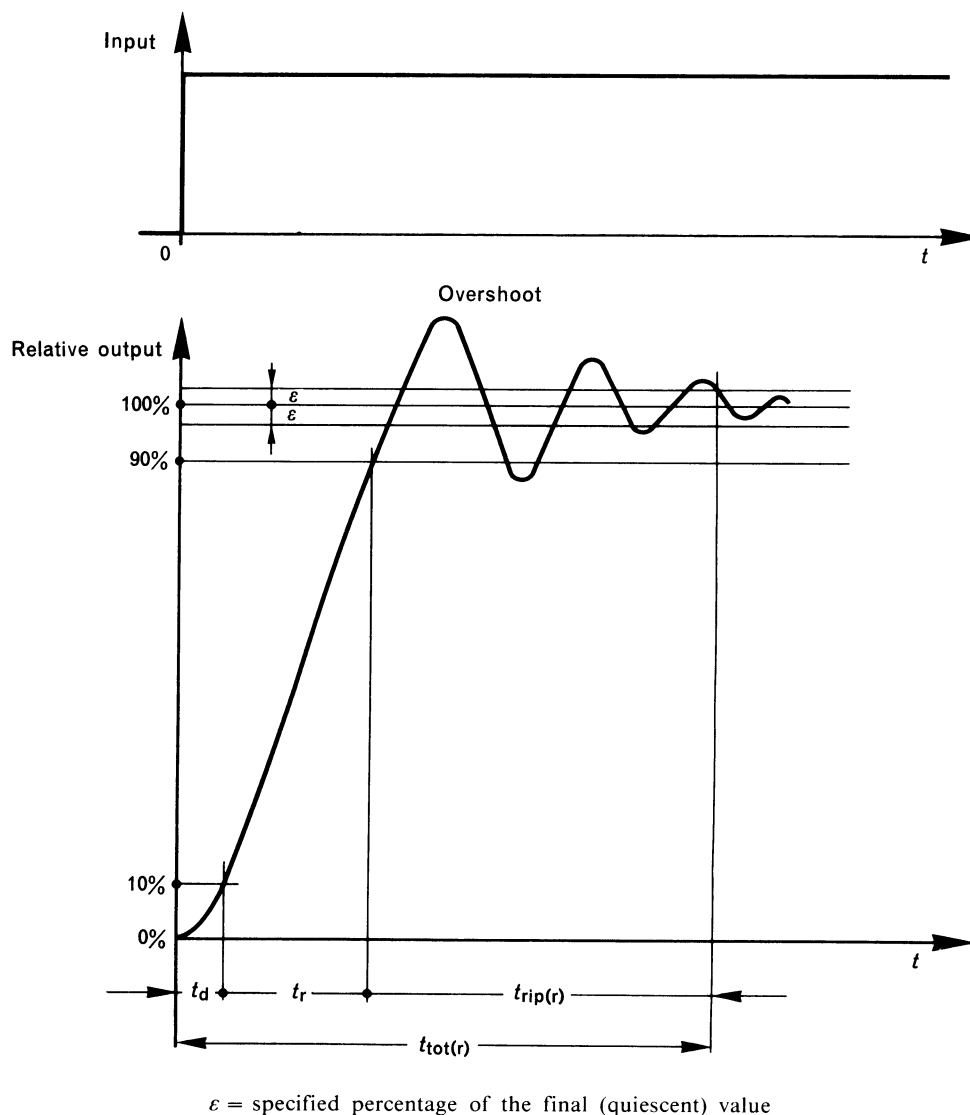


Figure 3 — Example of response times of linear amplifiers

These parameters should be stated as follows:

Typical and, where appropriate, maximum value under the following specified conditions:

- unity-gain configuration;
- input and feedback resistance values with which unity-gain configuration is realized;
- phase compensating conditions (configuration and values of the compensating network, if any);
- load conditions (configuration and values of the loading network);
- level of input signal.

NOTE The rise time of the input pulse should be negligible compared to the slope time of the operational amplifier.

5.1.4.4 Overshoot (k_{ov})

See Figure 3, page 20.

Maximum value under the same specified conditions as the response times.

5.1.4.5 Upper limiting frequency for full output voltage swing (where appropriate)

Typical and minimum values, for specified values of:

- supply voltage(s);
- unity-gain inverter configuration;
- input and feedback resistances with which unity-gain configuration is obtained;
- phase compensating conditions (configuration and values of the components of the compensating network, if any);
- load conditions (configuration and values of the components of the loading network);
- distortion factor of the output signal;
- output voltage.

5.1.5 Reverse transfer characteristics

Not appropriate.

5.1.6 Interaction between the amplifier and the supply lines

The following information should be given under appropriate specified conditions:

- a) Maximum signal from the amplifier to the supply lines.
- b) The transfer characteristic from the supplies to the input of the amplifier.
- c) The impedance of the amplifier at the supply terminals.

This should be specified both for steady state and transient conditions.

5.1.7 Noise (where appropriate)

Maximum value.

The noise should be specified in terms of noise factor or in terms of equivalent input voltage and/or current, for specified values of supply voltage(s), source resistance, frequency and bandwidth.

5.1.8 Cross-talk attenuation (for multiple amplifiers)

Minimum value for specified values of:

- supply voltage(s);
- amplitude of output signal;
- signal frequency;
- load and source impedances;
- additional components to be connected externally;
- conditions for other amplifiers.

5.2 Effects of variations of temperature or supply voltages on the essential characteristics (quoted in Sub-clause 5.1 of Section 2)

The changes in the following characteristics with temperature and supply voltages should be stated.

This information should be given either for the typical value of the characteristic or for the limit (maximum or minimum) value of the characteristic.

This information should normally be given as application data for the device, and not as acceptance criteria for acceptance against a specification. The data called for in Sub-clause 5.2.1 should be given at a specified value of supply voltage(s) and the data required in Sub-clause 5.2.2 should be given at a temperature of 25 °C.

5.2.1 Variation with temperature

- a) Power (or supply current) consumption (Sub-clause 5.1.1).
- b) Input offset voltage and/or current (Sub-clause 5.1.2.2).
- c) Input bias current (Sub-clause 5.1.2.3).
- d) Common-mode rejection ratio (Sub-clause 5.1.2.5).
- e) Open-loop gain (Sub-clause 5.1.4.1).

5.2.2 Variation with supply voltage(s)

- a) Power (or supply current) consumption (Sub-clause 5.1.1).
- b) Output voltage swing (Sub-clause 5.1.3.3).
- c) Open-loop gain (Sub-clause 5.1.4.1).

NOTE Additional information regarding the variation of certain parameters with supply voltage(s) may also be given.

6 Mechanical characteristics and other data

Clause 7 of Publication 747-1, Chapter VI, applies.

7 Application data

Information concerning the variations of the characteristics given in Sub-clause 5.1 with supply voltage, temperature, source and load impedances, may be given.

Any other pertinent information concerning particular applications may be given, e.g. curves of the typical variation of input or output impedances or admittances versus frequency, the other specified conditions remaining unchanged.

Any external elements to be associated with the integrated circuit should be referred to its terminals. These external elements should appear in two distinct tables:

- the first table should include the associated elements which are specific to a function, or which determine an operation;
- the second table should include the associated elements which serve as correcting elements.

Each table should include three columns:

- in the first column, the integrated circuit terminals concerned should be identified;
- in the second column, the nature of the external elements concerned should be indicated (for example: RC network);
- in the third column, the resulting characteristics of the integrated circuit plus the external elements should be indicated.

Section 3. Audioamplifiers, videoamplifiers and multichannel amplifiers for telecommunications

1 Function

Amplifiers intended for functions in audio, video and telecommunication equipment.

NOTE The following provisions apply to the three categories of amplifiers, unless otherwise stated.

2 Description of circuit

2.1 Technology

The technology used in the manufacture should be stated, e.g.: semiconductor monolithic integrated circuit, thin film integrated circuit, hybrid integrated circuit, micro-assembly, etc.

2.2 Details of outline and encapsulation

2.2.1 IEC and/or national reference number of the outline drawing.

2.2.2 Method of encapsulation.

2.2.3 Marking: the drawing of the case with the marking should be reproduced.

2.3 Block-diagram and terminal connections

The block-diagram and the identification of the connections should be shown on the same drawing. If the encapsulation has metallic parts, any connection to them from external terminals should be indicated. The connections with any associated external electrical elements should be stated (see also Clause 5).

As additional information, the complete electrical diagram can be reproduced, including significant parasitic elements, but not necessarily with indications of the value of the circuit components.

3 Ratings (limiting values)

The ratings given must cover the operation of the integrated circuit over the specified range of operating temperatures.

Where such ratings are temperature-dependent, this dependence should be indicated.

If externally connected elements have an influence on the ratings, the ratings should be given for the amplifier with the elements connected.

3.1 Electrical limiting values

3.1.1 Power supply voltage(s)

a) Maximum value(s) and polarity(ies).

b) Maximum value of the voltage between a common supply terminal and case or reference terminal, where appropriate.

NOTE The sequence of the application of supply voltages should be given, where appropriate.

3.1.2 Input terminal voltage(s) and/or current(s)

Maximum values.

3.1.3 Output terminal voltage(s) and/or current(s)

Maximum values.

3.2 Temperatures

3.2.1 Operating temperatures

Minimum and maximum values of ambient or reference-point operating temperature.

3.2.2 Storage temperatures

Minimum and maximum values.

3.3 Power dissipation (where appropriate)

Maximum value over the operating temperature range.

4 Recommended operating conditions (within the specified operating temperature range)

For all the sub-clauses of Clause 4 below, the variation with temperature should be stated, where appropriate.

4.1 Power supplies

Polarities, values and tolerances for voltages and/or currents.

4.2 Input terminals

4.2.1 Value(s) of the voltage(s) and/or current(s) of the input signal or of the impedance of the signal source.

4.2.2 Value(s) of the bias on the input terminals, where appropriate.

4.3 Output terminals

4.3.1 Nominal value(s) of the voltage(s) and/or current(s) of the output signal and of the load impedance.

4.3.2 Value(s) of the bias on the output terminals, where appropriate.

4.4 External elements

Values and tolerances for the external elements that must be associated with the circuit.

5 Electrical characteristics

Electrical characteristics should be stated as follows:

- a) If external elements are essential for the operation of the circuit, the electrical characteristics should include the effect of such external elements.
- b) If external elements are optional only, the electrical characteristics should be given for the integrated circuit alone. The effect of adding specified external elements on the characteristics should then be indicated in application data.

5.1 Characteristics at 25 °C (ambient or reference-point temperature)

5.1.1 Power (or supply current) consumption (P_{tot})

Typical value under specified conditions.

5.1.2 Input characteristics

5.1.2.1 Input impedance or admittance

In the case of high (low) impedance: typical and minimum (maximum) values of input impedance, or: typical and maximum (minimum) values of input admittance as function of frequency in the specified frequency range and under specified conditions.

In the case of impedance matching: the minimum return loss for the specified resistance in the specified frequency range and under specified conditions.

NOTE Return loss (in dB) = $20 \log_{10} \frac{Z + R}{Z - R}$

where Z is the impedance and R the specified resistance.

To characterize the input characteristics, scattering parameters s may be used, where appropriate.

5.1.2.2 Input bias current (where appropriate) (I_{IB})

Typical and maximum values under specified conditions.

5.1.2.3 Supply voltage rejection ratio (where appropriate) (k_{SVR})

Maximum value over the operating temperature range.

5.1.2.4 Offset voltage and/or current (where appropriate) (V_{IO} , I_{IO})

Maximum value.

5.1.2.5 Mean temperature coefficient of offset voltage or current (where appropriate) (α_{VIO} , α_{IIO})

Maximum value over the operating temperature range.

5.1.3 *Output characteristics*

5.1.3.1 *Output impedance or admittance*

In the case of low (high) impedance: typical and maximum (minimum) values of output impedance, or: typical and minimum (maximum) values of output admittance as function of frequency in the specified frequency range and under specified conditions.

In the case of impedance matching: the minimum return loss for a specified resistance in the specified frequency range and under specified conditions.

5.1.3.2 *Maximum signal output*

Minimum value of the output signal current, voltage or power for specified values of:

- distortion;
- load impedance;
- signal frequency;
- supply voltage(s);
- adjustment of gain control (if it exists).

Minimum overload point, under the same specified conditions, for multichannel amplifiers.

NOTE For the latter, see C.C.I.T.T. — White Book, Vol. III — Mar Del Plata 1968 — G 223 Item 6, p. 5.

5.1.4 *Forward transfer characteristics*

5.1.4.1 Voltage gain, or current gain, or forward transadmittance, or power gain, for specified values of:

- supply voltage(s);
- frequency;
- load and source impedance(s);
- adjustment of gain control (if it exists);
- amplitude of the output signal at which the gain is measured.

The parameter should be measured at an input signal lower than the A.G.C. threshold.

Minimum and typical values should be specified.

5.1.4.2 *Cut-off frequency, 3 dB point (for audio and video amplifiers only) (f_c)*

Maximum value of low frequency, 3 dB point, and minimum value of high frequency, 3 dB point.

For amplifiers transmitting the d.c. component, high cut-off frequency only.

5.1.4.3 *Gain and phase (and/or group-delay) versus frequency under specified conditions.*

a) *Gain*

Minimum and maximum values of voltage amplification and/or current amplification and/or power gain versus frequency, under specified conditions, for example, as shown in Figure 4.

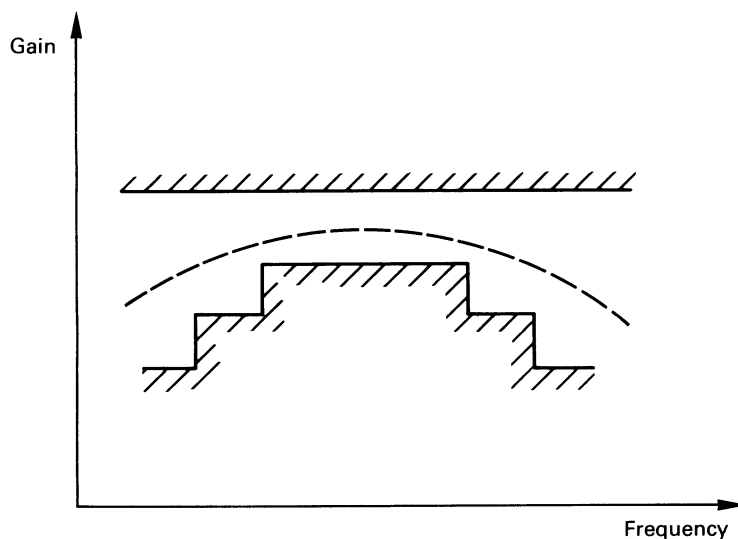


Figure 4 — Minimum and maximum values for gain versus frequency

b) *Phase*

Where appropriate, minimum and maximum phase and or group-delay (envelope-delay), under the conditions specified for gain versus frequency, for example, as shown in Figure 5.

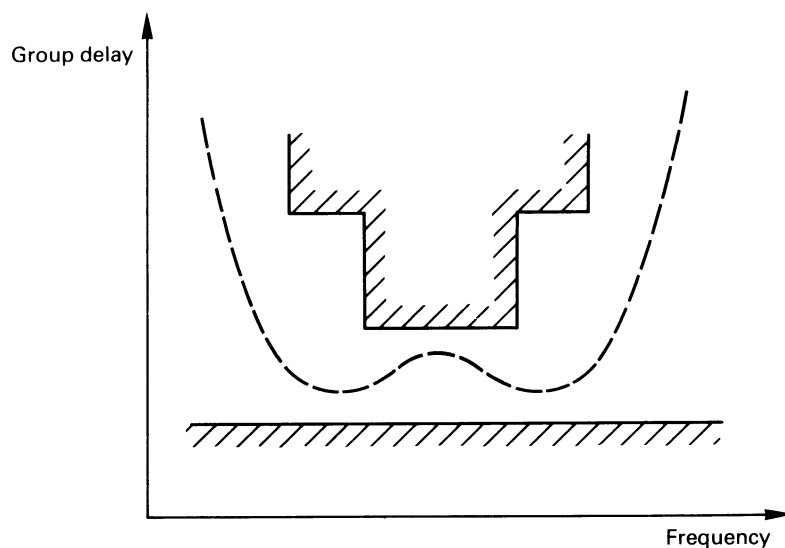


Figure 5 — Minimum and maximum values for group-delay versus frequency

5.1.5 *Reverse transfer characteristics*

Under consideration for multichannel amplifiers.

5.1.6 *Interaction between the amplifier and the supply lines*

For multichannel amplifiers and, where appropriate, for video amplifiers.

Under consideration.

5.1.7 *Noise (where appropriate)*

Maximum value.

The noise should be specified in terms of noise factor or in terms of equivalent input voltage and/or current, for specified values of supply voltage(s), source resistance, frequency and bandwidth.

5.1.8 *Distortion*

Distortion under specified conditions, especially: load impedance, output signal level, fundamental and component frequencies, supply voltage(s) and adjustment of gain control (if it exists).

- Maximum total harmonic distortion (for audio amplifiers only).
- Maximum harmonic distortion for the second and, where appropriate, for the third harmonic.
- Maximum intermodulation for the second and, where appropriate, for the third and higher order products (for video and multichannel amplifiers only).
- *Differential phase (error) and differential gain (error)* (for videoamplifiers only).

Maximum and/or typical values of differential phase (error) and differential gain (error) for specified values of:

- frequencies and levels of both low-frequency signal and superimposed high-frequency signal;
- load impedance.

5.1.9 *Pulse characteristics (where appropriate)*

Under consideration.

5.2 **Effects of variation of temperature and supply voltages on the essential characteristics** (quoted in Sub-clause 5.1 of Section 3)

The changes in the following characteristics with temperature and supply voltages should be stated.

This information should be given either for the typical value of the characteristic or for the limit (maximum or minimum) value of the characteristic.

This information should normally be given as application data for the device, and not as acceptance criteria for acceptance against a specification. The data called for in Sub-clause 5.2.1 should be given at a specified value of supply voltage(s) and the data required in Sub-clause 5.2.2 should be given at a temperature of 25 °C.

5.2.1 *Variation with temperature*

- a) Power (or supply current) consumption (Sub-clause 5.1.1).
- b) Input impedance or admittance (Sub-clause 5.1.2.1).
Magnitude and, where appropriate, real and/or imaginary part.
- c) Input bias current, when specified (Sub-clause 5.1.2.2).
- d) Offset voltage and/or current, when specified (Sub-clause 5.1.2.4).
- e) Output impedance or admittance (Sub-clause 5.1.3.1).
Magnitude and, where appropriate, real and/or imaginary part (not applicable for audioamplifiers).
- f) Gain (Sub-clause 5.1.4.1).
- g) Distortion (Sub-clause 5.1.8).

Where appropriate, total harmonic distortion (for audio and videoamplifiers) and maximum intermodulation (for multi-channel amplifiers).

5.2.2 Variation with supply voltages

- a) Power (or supply current) consumption (Sub-clause 5.1.1).
- b) Maximum signal output (Sub-clause 5.1.3.2).
- c) Gain (Sub-clause 5.1.4.1).
- d) Distortion (Sub-clause 5.1.8).

Where appropriate, total harmonic distortion (for audio and video amplifiers) and maximum intermodulation (for multi-channel amplifiers).

6 Mechanical characteristics and other data

Clause 7 of Publication 747-1, Chapter VI, applies.

7 Application data

Information concerning the variations of the characteristics given in Sub-clause 5.1 with supply voltage, temperature, source and load impedance may be given.

Any other pertinent information concerning particular applications may be given, e.g. optimum resistance of the generator for a minimum noise factor.

Section 4. R.F. and I.F. amplifiers

1 Function

An amplifier intended to be used for radio frequency or intermediate frequency sections of communications and television or radio receivers.

Types of amplifiers included are those having a gain control function or a limiter function: in the case of a gain control function, the control may either be determined entirely within the integrated circuit (A.G.C.) or be determined by the application of external control signals to a specified terminal.

2 Description of circuit

2.1 Technology

The manufacturing technology should be stated, for example, semiconductor monolithic integrated circuit, thin film integrated circuit, hybrid integrated circuit, micro-assembly, etc.

2.2 Details of outline and encapsulation

2.2.1 IEC and/or national reference number of the outline drawing.

2.2.2 Method of encapsulation.

2.3 Block-diagram and terminal connections

The block-diagram and the identification of the connections should be shown on the same drawing. If the encapsulation has metallic parts, any connection to them from external terminals should be indicated. The connections with any associated external electrical element should be stated (see also Clause 5).

As additional information, the complete electrical diagram can be reproduced, including significant parasitic elements, but not necessarily with indications of the values of the circuit components.

3 Ratings (limiting values)

The ratings given must cover the operation of the integrated circuit over the specified range of operating temperatures.

Where such ratings are temperature-dependent, this dependence should be indicated:

If externally connected elements have an influence on the ratings, the ratings should be given for the amplifier with the external elements connected.

3.1 Electrical limiting values

3.1.1 *Power supply voltage(s)*

- a) Maximum value(s) and polarity(ies).
- b) Maximum permissible ripple on the supply voltage(s).
- c) Maximum values of transients or spurious signals from the supplies for a specified time duration.
- d) Maximum value of the voltage between a common supply terminal and the case or a reference terminal, where appropriate.

NOTE The sequence of the application of supply voltages should be given, where appropriate.

3.1.2 *Input terminal voltage(s) and/or current(s)*

Maximum values with respect to a common reference terminal.

3.1.3 *Output terminal voltage(s) and/or current(s)*

Maximum values with respect to a common reference terminal.

3.1.4 *Other terminal voltage(s) and/or current(s) (for example A.G.C. terminal)*

Maximum values with respect to a common reference terminal.

3.2 Temperatures

3.2.1 *Operating temperatures*

Minimum and maximum values of ambient or reference-point operating temperature.

3.2.2 *Storage temperatures*

Minimum and maximum values.

3.3 Power dissipation (where appropriate)

Maximum value over the operating temperature range.

4 Recommended operating conditions (within the specified operating temperature range)

4.1 Power supplies

Polarity(ies), value(s) and tolerance(s) for voltages and/or currents and, where appropriate, impedance(s).

4.2 Input terminals

4.2.1 Value(s) of the voltage(s) and/or current(s) of the input signal and, where appropriate, of the impedance of the signal source.

4.2.2 Value(s) of the bias on the input terminals, where appropriate.

4.3 Output terminals

4.3.1 Nominal value(s) of the voltage(s) and/or current(s) of the output signal and, where appropriate, of the load impedance.

4.3.2 Value(s) of the bias on the output terminals, where appropriate.

4.4 Other terminals

Nominal value(s) of the voltage(s) and/or current(s) of the signals (for example A.G.C. voltage) and, where appropriate, of source and load impedances.

4.5 External elements

Values and tolerances for the external elements that must be associated with the circuit.

4.6 Signal frequencies

The range of operating signal frequencies for which the characteristics of the amplifier are valid.

5 Electrical characteristics

Electrical characteristics should be stated as follows:

- a) If external elements are essential for the operation of the circuit, the values of the electrical characteristics should be given with the specified external elements connected.
- b) If external elements are optional only, the electrical characteristics should be given for the integrated circuit alone. The effect on the characteristics of adding specified external elements should then be indicated in application data.

5.1 Characteristics at 25 °C (ambient or reference-point temperature)

5.1.1 *Power (or supply current) consumption* (P_{tot})

Typical and maximum values under specified conditions.

5.1.2 *Input characteristics*

5.1.2.1 *Input impedance or admittance*

In the case of high (low) impedance: typical and minimum (maximum) values of input impedance, or: typical and maximum (minimum) values of input admittance, as a function of frequency in the specified frequency range and under specified conditions, including, where appropriate, the A.G.C. or control conditions.

5.1.2.2 *Input bias current* (where appropriate) (I_{IB})

Typical and maximum values under specified conditions.

5.1.2.3 *Offset voltage and/or current* (where appropriate) (V_{IO} , I_{IO})

Maximum value.

5.1.2.4 *Supply voltage rejection ratio* (where appropriate) (k_{SVR})

Minimum value.

5.1.3 *Output characteristics*

5.1.3.1 *Output impedance or admittance*

In the case of low (high) impedance: typical and maximum (minimum) values of output impedance, or: typical and minimum (maximum) values of output admittance, as a function of frequency in the specified frequency range and under specified conditions, including, where appropriate, the A.G.C. or control conditions.

5.1.3.2 *Maximum output signal*

Minimum value of the output signal current, voltage or power for specified values for:

- load impedance;
- signal frequency;
- supply voltage(s);
- adjustment of gain control (where appropriate);
- distortion.

5.1.4 *Forward transfer characteristics*

5.1.4.1 *Gain*

Minimum and typical values of voltage gain, or current gain, or forward transadmittance, or power gain, for specified values of:

- supply voltage(s);
- frequency;
- source and load impedances;
- output signal amplitude;
- gain control giving maximum gain (where appropriate).

5.1.4.2 Control range of voltage gain (for amplifiers with facilities for externally applied gain control signals)

Minimum value of the total change in voltage gain (expressed in decibels) that may be achieved by the application of a specified range of d.c. voltage applied to the control-input terminal, for specified values of:

- supply voltage(s);
- frequency;
- source and load impedances;
- bias conditions at the control terminal;
- output voltage reference level.

5.1.4.3 A.G.C. range of input signal (for amplifiers with internal A.G.C.)

Minimum value of the change in input signal voltage (expressed in decibels) required to cause a specified change in output signal voltage, for specified values of:

- supply voltage(s);
- frequency;
- source and load impedances;
- range of output signal voltage levels for which the specified change of output is valid.

5.1.4.4 Input limiting voltage (for limiting amplifiers only)

Typical and maximum values of the input signal voltage that will cause the output signal to decrease 3 dB from its maximum level for specified values of:

- supply voltage(s);
- frequency;
- source and load impedances.

5.1.4.5 Cut-off frequency, 3 dB point (where appropriate) (f_c)

Maximum value of low frequency, 3 dB point, and minimum value of high frequency, 3 dB point, under maximum gain conditions. For amplifiers passing the d.c. component, high cut-off frequency only.

5.1.5 Reverse transfer characteristics (where appropriate)

Under consideration.

5.1.6 Average noise figure

Typical and, where appropriate, maximum values, for specified values of:

- supply voltage(s);
- input signal amplitude (where appropriate);
- bandwidth;
- source resistance;
- frequency.

5.2 Effects of variations of temperature and supply voltages on the essential characteristics (quoted in Sub-clause 5.1 of Section 4).

The changes in the following characteristics with temperature and supply voltages should be stated.

This information should be given either for the typical value of the characteristic or for the limit (maximum or minimum) value of the characteristic.

This information should normally be given as application data for the device, and not as acceptance criteria for acceptance against a specification. The data called for in Sub-clause 5.2.1 should be given at a specified value of supply voltage(s) and the data required in Sub-clause 5.2.2 should be given at a temperature of 25 °C.

5.2.1 Variation with temperature

- a) Power (or supply current) consumption (Sub-clause 5.1.1).
- b) Input impedance or admittance (Sub-clause 5.1.2.1).
Magnitude and, where appropriate, real and/or imaginary part.
- c) Output impedance or admittance (Sub-clause 5.1.3.1).
Magnitude and, where appropriate, real and/or imaginary part.
- d) Gain (Sub-clause 5.1.4.1), where appropriate.

5.2.2 Variation with supply voltages

- a) Power (or supply current) consumption (Sub-clause 5.1.1).
- b) Input impedance or admittance (Sub-clause 5.1.2.1).
Magnitude and, where appropriate, real and/or imaginary part.
- c) Maximum output signal (Sub-clause 5.1.3.2).
- d) Gain (Sub-clause 5.1.4.1), where appropriate.

6 Mechanical characteristics and other data

Clause 7 of Publication 747-1, Chapter VI, applies.

7 Application data

Information concerning the variations of the characteristics given in Sub-clause 5.1 with supply voltage, temperature, source and load impedances, may be given.

Any other pertinent information concerning particular applications may be given, for example, mounting conditions.

Section 5. Voltage and current regulators

1 Function

Regulators intended to be fed with an input d.c. voltage, in order to deliver a regulated output voltage (or current) which is either controllable by external elements or is fixed by internal elements.

2 Description of circuit

2.1 Technology

The technology used in the manufacture should be stated, for example: semiconductor monolithic integrated circuit, thin film integrated circuit, hybrid integrated circuit, micro-assembly, etc.

2.2 Details of outline and encapsulation

2.2.1 IEC and/or national reference number of the outline drawing.

2.2.2 Method of encapsulation.

2.3 Block-diagram and terminal connections

The block-diagram and the identification of the connections should be shown on the same drawing. If the encapsulation has metallic parts, any connection to them from external terminals should be indicated.

Any external elements required should be specified and their connections to the terminals of the device should be stated.

As additional information, the complete electrical diagram can be reproduced, including significant parasitic elements, but not necessarily with indications of the values of the circuit components.

3 Ratings (limiting values)

The ratings given must cover the operation of the integrated circuit over the specified range of operating temperatures.

Where such ratings are temperature-dependent, this dependence should be indicated.

3.1 Electrical limiting values

3.1.1 *Input voltage*

- a) Maximum value(s) and polarity, under continuous operation (including ripple).
- b) Maximum value of transient input voltage for a specified duration.
- c) Maximum value of permissible voltage between each input terminal and case or a reference terminal, where appropriate.

3.1.2 *Voltage difference between input and output*

Maximum value and polarity.

3.1.3 *Load currents*

Maximum values.

3.1.4 *Other currents* (for example, from a voltage-reference source)

Maximum values.

3.1.5 *Short-circuit conditions*

Any limiting conditions (for example: time, current) for which a short circuit can be applied.

3.2 Temperatures

3.2.1 *Operating temperatures*

Minimum and maximum values of ambient or reference-point operating temperature.

3.2.2 *Storage temperatures*

Minimum and maximum values.

3.3 Power dissipation

A curve of maximum power dissipation versus ambient or reference-point temperature.

4 Recommended operating conditions (within the specified operating temperature range)

For all the sub-clauses of Clause 4 below, the variation with temperature should be stated, where appropriate.

4.1 *Input terminals*

Minimum and maximum values of input voltage range.

4.2 *Output terminals*

4.2.1 *Voltage regulators*

Output current range and, where appropriate, load resistance and load capacitance and/or inductance. Maximum rate of change of output current.

4.2.2 *Current regulators*

Output voltage range and, where appropriate, load resistance and load capacitance and/or inductance. Maximum rate of change of the output voltage.

4.3 *Bias terminals*

Value(s) of the bias and recommended bias networks, where appropriate.

4.4 *External elements*

Value(s) and tolerance(s) of the external elements that must be associated with the circuit.

4.5 *Voltage difference between input and output* (where appropriate)

Minimum value.

5 Electrical characteristics

Electrical characteristics should be stated as follows:

- a) If external elements are essential for the operation of the circuit, the values of the electrical characteristics should be given with the specified external elements connected.
- b) If external elements are optional only, the electrical characteristics should be given for the integrated circuit alone. The effect on the characteristics of adding specified external elements should then be indicated in application data.

5.1 Characteristics at 25 °C (ambient or reference-point temperature)

In Sub-clauses 5.1.1, 5.1.2, 5.1.3 and 5.1.4, either formula (I) or (II) should be chosen consistently throughout.

5.1.1 Input regulation coefficient (formula I) or input stabilization coefficient (formula II) (for a voltage regulator)

$$(I) \frac{\Delta V_o}{V_o} \quad (II) \frac{\Delta V_o / V_o}{\Delta V_i / V_i}$$

Typical and maximum values for specified values of:

- input voltage range, either as a single range or as multiple ranges covering the full range of Sub-clause 4.1;
- nominal input voltage V_i (for formula II only);
- load current;
- nominal output voltage V_o (where this quantity is adjusted by external elements).

5.1.2 Input regulation coefficient (formula I) or input stabilization coefficient (formula II) (for a current regulator)

$$(I) \frac{\Delta I_o}{I_o} \quad (II) \frac{\Delta I_o / I_o}{\Delta V_i / V_i}$$

Typical and maximum values for specified values of:

- input voltage range, either as a single range or as multiple ranges covering the full range of Sub-clause 4.1;
- nominal input voltage V_i (for formula II only);
- nominal load current I_o ;
- load impedance.

5.1.3 Load regulation coefficient (formula I) or load stabilization coefficient (formula II), (for a voltage regulator)

$$(I) \frac{\Delta V_o}{V_o} \quad (II) \frac{\Delta V_o / V_o}{\Delta I_o / I_o}$$

Typical and maximum values for specified values of:

- output current range, either as a single range or as multiple ranges covering the full range of Sub-clause 4.2.1;
- nominal load current I_o (for formula II only);
- input voltage;
- nominal output voltage V_o (where this quantity is adjusted by external elements);
- external resistors, where appropriate.